ELEOCHARIS MICROFORMIS (CYPERACEAE): REDISCOVERED IN NORTH AMERICA FROM THE EDWARDS PLATEAU AND TRANS-PECOS REGIONS OF TEXAS

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ABSTRACT

Eleocharis microformis Buckley, Buckley's Dwarf Spike-rush, has been rediscovered from the Edwards Plateau and Trans-Pecos regions of Texas. A careful examination of recent collections as well as the few known historical specimens confirms it to be distinct from *E. geniculata* (L.) Roem. & Schult. and *E. atropurpuea* (Retz.) J. Presl & C. Presl. Henry K. Svenson placed *E. microformis* in synonymy under *E. geniculata* in 1939, and the name has been generally overlooked ever since. The evidence presented here supports the resurrection of Buckley's original epithet as a distinct species.

RESUMEN

Eleocharis microformis Buckley, Buckley's Dwarf Spike-rush, ha sido redescubierto en la regiones de Edwards Plateau y Trans Pecos de Texas. Un examen cuidadoso de colecciones recientes así como los pocos especimenes históricos conocidos confirman que es diferente de *E. geniculata* (L.) Roem. & Schult. y *E. atropurpuea* (Retz.) J. Presl & C. Presl. H.K. Svenson colocó *E. microformis* en la sinonimia de *E. geniculata* en 1939, y el nombre ha sido generalmente omitido desde entonces. La prueba presentada aquí soporta la resurrección del epíteto original de Buckley como una especie distinta.

INTRODUCTION

Eleocharis microformis Buckley, in subgenus *Eleocharis* sect. *Eleogenus*, subser. *Rigidae* (González-Elizondo & Peterson 1997), was described by Samuel Bostford Buckley in 1862 (Buckley 1862) from a specimen collected in "northern Texas" (*Buckley s.n.*, PH). Later that year Asa Gray remarked that *E. microformis* "[a hybrid name] is near *E. intermedia*, Schultes" (Gray 1862). Buckley responded by saying *E. microformis* "is probably a good species" (Buckley 1870). Svenson (1939) reduced *E. microformis* to a synonym under *E. geniculata* (L.) Roemer & J.A. Schultes and the name has been overlooked in taxonomic treatments for the last 74 years. Although described from Texas, *E. microformis* has never been mentioned either as a species or as a synonym in any Texas or North American flora or checklist (Gould 1962; Correll & Johnston 1970; Correll & Correll 1972; Godfrey & Wooten 1979; Hatch et al. 1990; Kartesz 1994; Jones et al. 1997, Diggs et al. 1999; Kartesz & Meacham 1999; Smith et al. 2003). Hooker and Jackson (1895), in the first volume of *Index Kewensis*, following Gray's comment, gave *Eleocharis intermedia* Schult. as a synonym of *E. microformis*. *Eleocharis intermedia* is a species in section *Eleocharis*, known from the northeastern United States, with golden-brown, compressed-trigonous achenes with narrowly pyramidal tubercles. In contrast, *E. microformis* is in section *Eleogenus* with shiny black, biconvex achenes with depressed-umbonate tubercles.

Taxonomic History

The epitaphs *Eleocharis geniculata*, *E. caribaea* (Rottb.) S.F.Blake, *E. microformis*, and *E. elegans* Roem. & Schult. have been confused for decades (Svenson 1929, 1937, 1939, 1957). Henry Knute Svenson, who for decades worked on the genus *Eleocharis*, recognized *E. microformis* as a distinct species in the first part of his "Monographic studies in the genus *Eleocharis*" (Svenson 1929). Of the collections from six different locations that Svenson examined, he annotated each one as *E. microformis* at least once and some a second time from 1925 to 1937. From 1948 to 1967 he re-annotated most of these specimens as *E. caribaea*, which he later (Svenson 1939)

treated as a synonym of *E. geniculata*. He stated, "The dwarf round-headed *E. microformis* from Texas with achenes 0.7–0.9 mm long, often confused with *E. atropururea*, I now believe to be a small extreme of *E. geniculata* (*E. caribaea*), similar to specimens from Nicaragua (*Maxon, Harvey, & Valentine 7291*, NY) and from Honduras (*Schipp No. 913 & Standley No. 56671*, NY)" (Svenson 1939). Upon recent examination by O'Kennon, the collections from Honduras appeared to be smallish but otherwise typical *E. geniculata*. The collection from Nicaragua was a short *E. geniculata* with smaller than usual achenes (0.7–0.8 mm long), but had none of the characteristics of *E. microformis*. Svenson re-annotated a Reverchon collection (*1672*, TEX) of *E. microformis* from Blanco County, Texas as *E. caribaea* with the comment that it was a "form with small heads and small achenes ..."

Of the five taxa within subser. *Ridigae*, only *E. atropurpurea* (Retz.) J. Presl & C. Presl and *E. geniculata* are widespread in North America (González-Elizondo & Peterson 1997,). *Eleocharis bahamensis* Boeckeler and *E. sintenisii* Boeckeler are endemic to the Bahaman islands and Puerto Rico, respectively, and *E. microformis* is endemic to Texas. Upon cursory examination, *Eleocharis microformis* resembles both *E. atropurpurea* and *E. geniculata*. Herbarium specimens of *E. geniculata* and *E. atropurpurea* were examined from the following herbaria: BRIT, SMU, TEX-LL, GH, MO, US, NY, and TAES. Twenty-one specimens (including duplicates) were identified matching Buckley's description of *E. microformis*. Upon examination of specimens of *E. geniculata, E. atropurpurea*, and *E. microformis,* it became immediately obvious to us that *E. microformis* was distinct and supported the resurrection of Buckley's original name.

Eleocharis atropurpurea is easily distinguished from the other species by its small (0.4–0.5 mm) black achenes with a small subconic tubercle usually less than ¼ as wide as the achenal body, generally with bright white bristles shorter than to equaling the achenal body (Table 1). *Eleocharis microformis* is distinguished from *E. geniculata* by its smaller achenes (less than 0.65 mm vs. greater than 0.7 mm) with a larger tubercle (½ as broad as the achene vs. ⅓ as broad), fewer scales per spikelet (generally fewer than 20 vs. more than 28), shorter scales (1 mm vs. 1.5–2 mm), shorter bristles (shorter than or equaling achene length vs. longer than achene), thinner culms (0.2–0.3 mm vs. 0.5–1.0 mm), and arching to ascending habit (vs. erect to ascending) (Table 1, Fig. 1).

Eleocharis microformis and *E. geniculata* are sympatric on the Edwards Plateau, and we have observed them growing side by side on four sites. Although there are minor variations in size within each species and occasional overlaps in size between these species, no recognizable intermediates have been observed. *Eleocharis microformis* also occurs on the same sites with *E. atropupurea*, a diminutive species with which it is often confused in the field but is distinguished by its smaller tubercle and achenes (see key and Figures 1 & 2 herein).

Distribution

The first known collections of what Buckley later called *Eleocharis microformis* were made in July of 1852 by Charles Wright (*1930, 1932, 1961* GH) while he "was on the Pecos on his way back to San Antonio (Shaw 1987)." Label information for no. 1930 indicates "Howard Creek, Texas" on 4 July. Howard Creek meets the Pecos River in northwestern Val Verde County, about 40 km (25 mi) downriver from Live Oak Creek where Wright made collections two days prior (Gray 1852–1853). This is likely the "Howard Creek" cited on the specimen. Numbers 1932 and 1961 lack locality information but are probably in the vicinity (Svenson 1929).

Eleocharis microformis was next found by Buckley in June 1861 (*s.n.*, PH), and described by him in 1862. In the protologue of his collection, Buckley did not include an exact location for that 1861 collection other than "northern Texas." According to Dorr and Nixon (1985), Buckley worked as a geologist and naturalist for the Geological Survey of Texas in June 1861, and he traveled from Austin to work on the survey of Navarro County about 250 km north of Austin. This apparently was his northern-most excursion in Texas and the specimen was likely collected somewhere along his route.

Reverchon collected *E. microformis* in 1885 from "swamps" in Blanco Co. (*1672*, GH, LL, MO, NY, US; *3594*, MO, NY, US), and from "Texas" (*s.n.* GH). Reverchon's collection number *1673* of *E. geniculata* (*Reverchon 1673*, MO) was from the banks of the Pedernales River in Blanco Co. It is likely that his "swamps" are also

TABLE 1. Character differences between *Eleocharis microformis* and *E. geniculata*. Measurements of the achenes are for the achenal body itself not including the tubercle. Measurements indicated in the Flora of North America treatment for the genus *Eleocharis* (Smith et al. 2003) were likely inclusive of *E. microformis* specimens. The measurements indicated below are revised to recognize *E. microformis* as a distinct species.

Character	*Eleocharis microformis*	*Eleocharis geniculata*
1. achene length	0.5–0.65mm long	0.7–0.9(–1.1) mm
2. tubercle width relative to achene	fully ½ as broad	1/3 as broad
3. spikelet size	2–3(–4) mm long	(3–)4–7 mm long
4. spikelet shape	ellipsoid to ovoid	globose to ovoid
5. number of spikelet scales	10–20(–26)	28–50
6. scale color	brownish-orange to reddish-brown with conspicuous yellowish-green keel	stramineous-buffy with inconspicuous tan to pale-greenish keel
7. scale length	1 mm long	1.5–2 mm long
8. bristle length	generally shorter than or equal to achene	generally longer than or equal to achene
9. number of bristles	4–6	6–8 or lacking
10. culm length	(1–)3–6(–9) cm	(5–)10–25(–45) cm
11. culm thickness	0.2–0.3 mm	0.5–1.0 mm
12. culms arching or erect	arching to ascending	generally erect to ascending

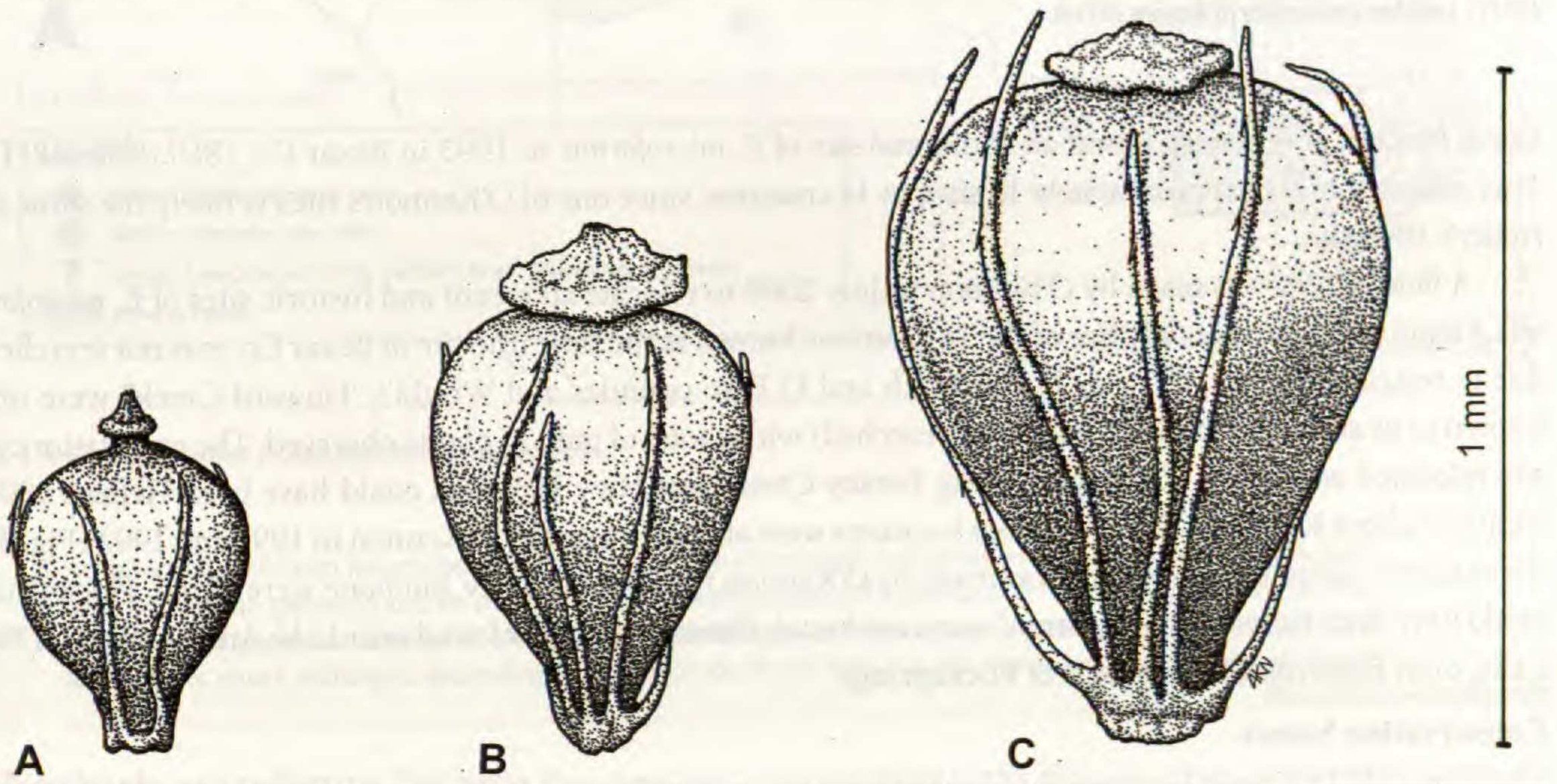

FIG. 1. Line drawings of achenes of three closely related taxa: A. *Eleocharis atropurpurea* (*O'Kennon 10663*). B. *Eleocharis microformis* (*O'Kennon 10171*). C. *Eleocharis geniculata* (*O'Kennon 10710*). Illustration by Amanda Neill.

somewhere along the Pedernales River. Palmer also collected along the Pedernales River in Blanco Co. in 1928 (*Palmer 33921*, MO). In 1892, E.N. Planks collected the plant in Lampasas Co. (*s.n.*, NY), but a location was not indicated. In 1894, Arthur Heller (*1851*, GH, MO, SMU, US), collected plants "about Kerrville" in Kerr County, and B.C. Tharp collected two specimens in Travis Co. near Lake Austin in 1922 (*2128*, *2129*, US). Victor L. Cory collected *E. microformis* in Reagan Co. south of Big Lake in 1929 (*s.n.*, GH) and 1939 (*32765*, TAES), and in 1934 from Edwards Co. southeast of Rocksprings (*9816*, GH).

Since Wright's first collection of *E. microformis* in 1852 until 1988 (136 years), there had been only 15 collections made, likely from only nine locations. Richard Worthington made a collection in the Indio Mountains in Hudspeth Co. in 1988 (*Worthington 17456*, UTEP) and in the Franklin Mountains in El Paso Co. in 1993 (*Worthington 22241*, UTEP). Eight additional sites were located in Gillespie, Kerr, Llano, Mason, and Uvalde counties by O'Kennon in 1991 and 1992 during research on the flora of the Edwards Plateau of central Texas.

Fig. 2. Photographs of achenes of three closely related taxa. From left to right: *Eleocharis atropurpurea* (*O'Kennon 10663*). *Eleocharis microformis* (*O'Kennon 10171*). *Eleocharis geniculata* (*O'Kennon 10710*).

Estes, Proctor, and Benesh found an additional site of *E. microformis* in 1995 in Bexar Co. (*BUL0856*, BRIT). This makes a total of approximately 18 sites in 14 counties, since one of O'Kennon's sites is likely the same as Heller's 1894 site.

A field survey was made by O'Kennon in July 2009 to relocate all recent and historic sites of *E. microformis*. Plants were found at only five of the 14 locations known at the time (the site in Bexar Co. was not searched due to restricted access, the sites in Hudspeth and El Paso counties and Wright's "Howard Creek" were unknown to us at the time and have not been searched) with a total of only 37 plants observed. The only historical site relocated was south of Kerrville along Turkey Creek near Hwy 16 which could have been Heller's 1894 location "about Kerrville". The other four locations were at sites located by O'Kennon in 1991 and 1992 (Fig. 3). An extensive search for the plants was made by O'Kennon in Blanco County, but none were found. Places that could have been Reverchon's "Swamps" were not found. Plants were never found near Lake Austin, south of Big Lake, or in Edwards Co. southeast of Rocksprings.

Conservation Status

There are only 18 known locations for *Eleocharis microformis* in the world in 14 Texas counties. As of 2009, only 5 of the 14 sites surveyed had extant populations. Seven of the historic collection locations have not been seen in over 70 years and may be extirpated. With so few sites, this Texas endemic is rare and perhaps warrants conservation status.

KEY TO NORTH AMERICAN *ELEOCHARIS* (SUBGENUS *ELEOCHARIS* SECT. *ELEOGENUS* SUBSERIES RIGIDAE)

NOTE, IN THIS KEY, THE ACHENE IS THE ACHENAL BODY NOT INCLUDING THE TUBERCULE

1. Distal leaf sheaths often disintegrating, thinly membranous-transluscent, prominently inflated and wrinkled; achenes stramineous to green or dark brown; creeping rhizomes present _____ (Subser. *Ocreatae*) **Eleocharis flavescens**
1. Distal leaf sheaths evident, rarely disintegrating, firmly membranous to papery, not prominently inflated or conspicuously wrinkled; achenes bright shiny black; creeping rhizomes absent _____ (Subser. *Rigidae*)
   2. Achenes 0.4–0.5 mm long; tubercle subconic, ¼ or less as wide as achene _____ **Eleocharis atropurpurea**
   2. Achenes 0.5–1.1 mm long; tubercle depressed, more than ¼ as wide as achene.
      3. Achenes 0.7–0.9(–1.1) mm long; tubercle depressed, only ⅓ as broad as the achene; bristles (0–)6–8, brownish, generally exceeding the achene or absent; spikelets globose to ovoid, (3–)4–7 mm long, 28–50-flowered; spikelet scales firm, stramineous-buffy with an inconspicuous tan midrib, 1.5–2 mm long; plants generally strictly erect to ascending, culms (5–)10–25(–45) cm high, 0.5–1 mm thick (widespread in warm or tropical regions) _____ **Eleocharis geniculata**

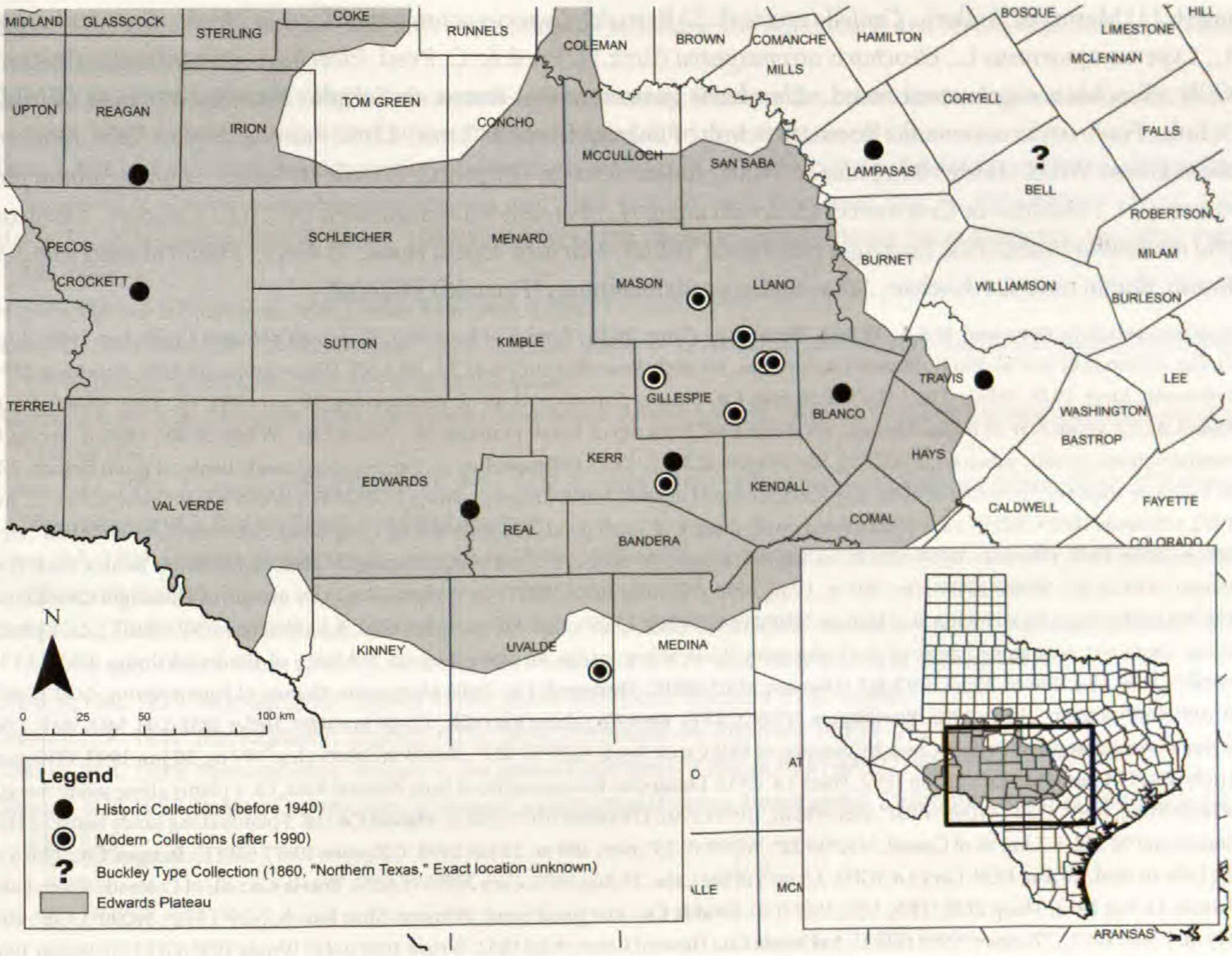

Fig. 3. Known distribution of *Eleocharis microformis* in Texas.

3. Achenes 0.50–0.65 mm long; tubercle depressed-umbonate, at least ½ as broad as the achene; bristles 4–6, light-brown to whitish, generally shorter than the achene; spikelets ellipsoid to ovoid, 2–3(–4) mm long, 10–20(–26)-flowered; spikelet scales thin, brownish-orange to reddish-brown with a conspicuous greenish-yellow midrib, 1 mm long; plants dwarf, arching to ascending, culms (1–)3–6(–9) cm high, 0.2–0.3 mm thick (central and west Texas) **Eleocharis microformis**

Eleocharis microformis Buckley, Proc. Acad. Nat. Sci. Philadelphia 14:5–10. 1862. Type: U.S.A. Texas: northern Texas, Jun 1861, *Buckley* s.n. (lectotype: PH!)

Plants annual, densely tufted, without creeping rhizomes. **Culms** arching to ascending, setaceous, lightly sulcate, (1–)3–6(–9) cm long, 0.2–0.3 mm thick. **Leaves:** distal leaf sheaths firm, distally tightly sheathing, apex acute. **Spikelets** ellipsoid to ovoid, acute, 10–20(–26)-flowered, 2–3(–4) mm long; floral scales obtuse, often rufescent, with a greenish-yellow midrib and light brown hyaline margins. **Flowers:** perianth bristles 4–6, light-brown to whitish, generally shorter than the achene, retrorsely barbed (120×); styles bifid. **Achenes** broadly obovoid-pyriform, shiny black when ripe, biconvex, 0.5–0.65 × 0.4–0.5 mm, not constricted proximal to tubercle, surface minutely pitted at 40×. **Tubercles** white, depressed-umbonate, at least ½ as broad as the achene.

Fruiting Jun–Aug. Wet areas including pond margins, creeks, riverbanks, and ephemeral swales in a variety of soil substrates including sand, clay, and granite. Specimens examined with known site locations are from central and west Texas. The exact location of the type collection protologue from "northern Texas" is unknown; elevation 258–1455 m.

Associated plants include: *Ammannia coccinea* Rottb., *Ammannia robusta* Heer & Regel, *Lysimachia mini-*

ma (L.) U.Manns & Anderb., *Centella erecta* (L.f.) Fernald, *Cyperus acuminatus* Torr. & Hook., *Cyperus haspan* L., *Cyperus squarrosus* L., *Eleocharis atropurpurea* (Retz.) J. Presl & C. Presl, *Eleocharis coloradoensis* (Britton) Gilly, *Eleocharis engelmannii* Steud., *Eleocharis geniculata* (L.) Roem. & Schult., *Eleocharis obtusa* (Willd.) Schult., *Fimbristylis autumnalis* Roem. & Schult., *Fimbristylis vahlii* (Lam.) Link, *Fuirena simplex* Vahl, *Heteranthera limosa* Willd., *Isoetes lithophila* N. Pfeiff., *Juncus texanus* (Engelm.) Coville in Small, *Limnosciadium pinnatum* (DC.) Mathias & Constance, *Lindernia dubia* (L.) Pennell var. *anagallidea* (Michx.) Cooperr., *Hemicarpha micrantha* (Vahl) Pax, *Ludwigia glandulosa* Walter, *Marsilea vestita* Hook. & Grev., *Pilularia americana* A. Braun, *Rotala ramosior* Koehne, *Schoenoplectus saximontanus* (Fernald) J.Raynal.

Voucher specimens examined: **U.S.A. TEXAS. Bexar Co.:** Camp Bullis, Pond E of Buck Hill, W branch of Lewis Creek, Jun 1995, *Estes, Procter, & Benesh BUL0856* (BRIT). **Blanco Co.:** swamps, Jul 1885, *Reverchon 1672* (GH, LL, MO, NY, US); swamps, Jul 1885, *Reverchon 3594*; Pedernales River, 1928, *Palmer 33921* (MO). **Edwards Co.:** Nueces Canyon 14¼ mi SE Rocksprings, 10 Sep 1934, *V.L. Cory 9816* (GH). **El Paso Co.:** 0.3 air mi NW of Indian Springs, 1.8 air mi ENE from top of North Franklin Mt., N31°54'30", W106°28'30", 4800 ft, spring in canyon bottom, granitic substrate, 3 Jul 1993, *Worthington 22241* (UTEP). **Gillespie Co.:** ca. 9 plants along sandy banks of Knott Branch, 230 m E of State Highway 16 on Old Willow City Road, 21 km N of Main Street Fredericksburg, N30°24'47", W098°44'03", elev. 527 m, 22 Jun 1992, *O'Kennon 10675* (BRIT); ca. 5 plants along sandy margin of small pond, Old Willow City Loop Road, N30°24'46", W098°41'53", elev. 563 m, 30 Jul 1992, *O'Kennon 10704* (BRIT); ca. 8 plants along clay margin of pond along Threadgill Creek on McGinley Ranch, 9 km N of Harper, N30°21'50", W099°13'05", elev. 604 m, 1 Aug 1992, *O'Kennon 10706* (BRIT); ca. 6 plants along clay margin of Threadgill Creek along FM 783 at McGinley Ranch, 9 km N of Harper, N30°21'44", W099°13'09", elev. 610 m, 31 Jul 1992, *R.J. O'Kennon 10707* (BRIT); ca. 6 plants along sandy wet area along banks of the Pedernales River below bridge on State Hwy 16, 5.8 km S of Fredericksburg, N30°13'13", W098°52'09", elev. 486 m, 30 Jul 1992, *R.J. O'Kennon 10705* (BRIT). **Hudspeth Co.:** Indio Mountains, vicinity of Squaw Spring, N30°47'40", W105°00'45", 4200 ft, 18 Sep 1988, *Worthington 17456* (UTEP). **Kerr Co.:** about Kerrville, 12–19 Jun 1894, *Heller 1851* (GH, MO, SMU, US); 6 plants along margin of Turkey Creek by crossing of Fall Creek Road, N29°57'40.7", W099°10'28.8", elev. 499 m, 30 Jun 1993, *O'Kennon 11696* (BRIT). **Lampasas Co.:** 21 Sep 1892, *Plank s.n.* (NY). **Llano Co.:** Enchanted Rock State Natural Area, ca. 5 plants along sandy margin of Moss Pond, N30°30'33", W098°49'31", elev. 458 m, 10 Oct 1991, *O'Kennon 10171* (BRIT). **Mason Co.:** ca. 5 plants along sandy banks of Hay Branch on FM 152, 8.7 km W of Castell, N30°39'22", W099°01'13", elev. 384 m, 25 Jun 1992, *O'Kennon 10677* (BRIT). **Reagan Co.:** 2 mi S of Big Lake in mud, 24 Aug 1939, *Cory s.n.* (GH); 2.5 mi S of Big Lake, 24 Aug 1939, *Cory 32765* (TAES). **Travis Co.:** silt of Colorado River, Lake Austin, 12 Aug 1922, *Tharp 2128* (TEX, US); *2129* (US). **Uvalde Co.:** margin of pond, Winston-Mize Ranch, N29°13'16", W099°13'36", elev 258 m, 7 May 2005, *O'Kennon 19994* (BRIT). **Val Verde Co.:** Howard Creek, 4 Jul 1852, *Wright 1930* (GH); *Wright 1932* (GH, US); *Wright 1961* (GH, US). **County unknown:** northern Texas, Jun 1861, *Buckley s.n.* (PH); "Texas," no date, *Reverchon s.n.* (GH).

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